

FINAL REPORT
FOR
ADP STUDY OF MAGNETIC CATAclySMIC BINARIES
NASA GRANT NAG-8732

I. STRATEGY OF INVESTIGATION

This grant supported study of the physics of magnetic cataclysmic binaries through analysis of Einstein and EXOSAT archival data on the DQ Her stars AE Aqr and H0542-407, and modeling of the results in terms of the well-known X-ray spectrum of accreting white dwarfs, extended into the previously little-explored non-hydrodynamic regime. The grant funded work by the principal investigator, Don Q. Lamb; co-investigator Keith Mason (MSSL, England); postdoctoral associate Simon Rosen (MSSL, England), who visited the University of Chicago for 3 months as part of this project and whose visit was partially funded by the Science and Engineering Council of Britain; and Nick Kylafis (University of Crete, Greece), who visited the University of Chicago for 4 months as part of this project.

II. ACCOMPLISHMENTS

The standard theoretical model of magnetic cataclysmic variables predicts extreme ultraviolet or soft X-ray emission due to reprocessing by the stellar surface of both the cyclotron optical light and bremsstrahlung hard X-rays produced in the hot, post-accretion shock emission region. No extreme ultraviolet or soft X-ray component has yet been observed from the DQ Her stars. In contrast, the presence of an intense extreme ultraviolet or soft X-ray component is a striking feature of the AM Her stars. Measurement of the temperature and luminosity of this component is difficult. Thus its intensity, and therefore its origin, remains highly controversial. In a review article, we have summarized the current status of the theoretical ideas which have been proposed to explain it and described the way in which extreme ultraviolet spectral observations can clarify the situation. We have also discussed the possibility that extreme ultraviolet spectral observations may be able to detect the analogous component in the DQ Her stars.

The discovery of optical pulsations from AE Aquarii at a period of 33 seconds implies that this system contains a rapidly rotating magnetic white dwarf. The subsequent discovery of many other systems containing magnetic white dwarfs rotating much more slowly led to suggestions that the AE Aquarii system is fundamentally different from these so-called DQ Her systems. In a paper submitted for publication, we report the results of simultaneous Einstein and IUE observations of AE Aquarii which demonstrate that it is a canonical DQ Her system. Further, we are able to demonstrate, indirectly, the existence of an intense extreme ultraviolet component in this DQ Her star analogous to that in the AM Her stars.

X-ray observations of the DQ Her system H0542-407 reveal modulations at the spin period, the orbital period, and a sideband period corresponding to the frequency difference between the spin and orbital periods. This system is unique to date among DQ Her systems in showing X-ray modulation at this sidereal period or, indeed, at any period besides the spin and orbital periods. In an article submitted for publication, we report the results of further analysis of the EXOSAT data which determine the properties of the sideband

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modulation. We then compare and discuss explanations of the modulation in terms of reflection or amplitude modulation due to magnetic gating. We conclude that, contrary to a previous suggestion, this system contains an accretion disk around the magnetic white dwarf.

The X-ray emission regions of many AM Her stars are thought to encompass physical conditions under which the validity of the hydrodynamic approximation breaks down. In a paper in preparation, we have investigated this little-explored regime, and studied the ultraviolet and X-ray emission expected from such non-hydrodynamic emission regions. The results have important implications for the observed X-ray properties of AM Her and DQ Her stars.

III. PUBLICATIONS DURING THIS GRANT

The following is a list of papers supported by the grant and published during the past two years:

Extreme Ultraviolet Emission from Magnetic Cataclysmic Binaries (D. Q. Lamb), in *Extreme Ultraviolet Astronomy*, ed. R. F. Malina (Cambridge: Cambridge U. Press), pp. 193-212 (1991).

Analysis of *Einstein* and IUE Observations of the Magnetic Cataclysmic Binary AE Aquarii (D. Q. Lamb, J. Patterson, M. Miller, J. E. Deeter, K. Beuermann, and J. C. Raymond), *Ap. J.*, submitted (1991).

The Unique X-Ray Behavior of the Magnetic Cataclysmic Binary 1H0542-407 (S. R. Rosen, D. Q. Lamb, and K. O Mason), *M.N.R.A.S.*, submitted (1991).

X and UV Radiation from Accreting White Dwarfs. VI. Strongly Magnetic Stars (N. D. Kylafis and D. Q. Lamb), *Ap. J.*, to be submitted (1991).